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Texas Agricultural Extension Service

Biological Pest Control

Biological Control of Insect Pests in Wheat

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All insects have natural enemies which, in addition to weather and food supply, limit their populations. This process, unaided and often unrecognized by man, is termed natural control. It is important to recognize the impact of natural control factors and, where possible, encourage their action.

Biological control is the use of natural enemies to control insect pests. The ancient Chinese distributed nests of predatory ants among citrus trees to control caterpillars and borers. Today, biological control is an increasingly important component of integrated pest management (IPM) programs for agriculture as well as for urban environments.

Biological control does not present the human health and environmental concerns associated with chemical pesticide use. Nor is there much chance pests will develop resistance to natural enemies, as commonly occurs with insecticides. However, there should be different expectations for biological control than for chemical control. Natural enemies are living organisms with specific environmental requirements and behaviors. While insecticides often produce rapid, uniform control of insect pests, weeks, months or even years may be required before natural enemies effectivly control pests. As biological control takes effect and pests become scarce, their natural enemies may leave the area. Adverse weather conditions or changes in crop production practices also can reduce populations of natural enemies. In both cases, pest outbreaks may recur.

Using biological control effectively requires a good understanding of the biology of the pest and its natural enemies, as well as the ability to identify their life stages in the field. Frequent field scouting also is necessary to monitor natural enemies and evaluate their impact on pest populations.

Biological Control and Integrated Pest Management in Wheat

Biological control is most effective when used with other compatible pest control practices in an integrated pest management (IPM) program. These practices include cultural control, planting pest resistant varieties and using selective insecticides when other practices fail to keep pest numbers below the economic threshold. These practices and economic thresholds are detailed in the Extension publication "*Managing Insect and Mite Pests of Texas Small Grains,*" B-1251, available from your county Extension office.

Biocontrol Agents

Natural enemies of insect and mite pests are classified as parasites, predators or pathogens. Parasites are insects that require only one host to complete their development. The adult typically lays her egg in or on the host. The parasite larva feeds on the host, eventually killing it. The adult parasite then

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emerges from the dead host's body. Parasites often attack only one or a few related pest species. Many important parasites are small wasps and flies.

Predators are the lions and wolves of the insect world. During their life cycles they eat many insect pests. Predators usually feed on a greater variety of insect species than do parasites. Lady beetles and lacewing larvae are common insect predators.

Insects are subject to diseases caused by viruses, bacteria, nematodes and fungal pathogens. Disease outbreaks can rapidly reduce the populations of pest species when conditions favor infection and transmission. Some pathogens are commercially cultured and sold, and can be used much like an insecticide for pest control.

Methods of Biological Control

The three approaches to biological control of insect and mite pests are importation, conservation and augmentation of natural enemies.

Importation is the release of natural enemies into areas where they do not occur naturally. Some pest species have been accidentally brought into the U.S. from other countries. Natural enemies from the pest's native home are then identified, imported and released. If successful, the natural enemy will establish permanent populations and control the pest without the need for further releases.

Conservation is the protection and encouragement of existing populations of natural enemies. It is important to recognize natural enemies in the field and be aware of their beneficial actions. Natural enemies can be protected by minimizing insecticide treatments and, when possible, selecting products less toxic to beneficial insects. It is sometimes possible to modify cultural practices so that they favor the development of natural pest enemies.

Augmentation is the purchase and periodic release of natural enemies that do not naturally occur in sufficient numbers to provide pest control. As an example, parasitic wasps and predatory mites are commercially reared and sold for the control of pests in greenhouses.

Augmentative releases may be designed to "seed" natural enemy populations by releasing a few insects in the hope that they will increase rapidly to effective numbers (inoculative releases). Or, they may involve the release of large numbers of natural enemies to rapidly reduce pest infestations (inundative releases).

Augmentative releases are often used much like an insecticide. However, because natural enemies are living organisms, their effects are much more complex and variable than those of chemical insecticides. Release programs may fail if too few beneficial insects are released, weather conditions are unfavorable for their survival or reproduction, releases are not properly timed, the beneficials leave the field, or the species released is not adapted to the particular pest or crop situation.

Important questions to ask when considering an augmentation program include:

1. Has research shown that a release program is effective for the particular pest, crop and local situation?
2. Are the proposed release rates sufficient to protect crop yields? When is the best time to release the natural enemy in relation to the pest's life cycle?
3. Will the species of natural enemy to be used attack the target pest?
4. Are releases compatible with the need to apply insecticides for other crop pests and with other crop production practices?
5. Are the natural enemies alive and active when released? What quality control practices does the company use?
6. What directions and assistance does the company provide regarding the handling, release and evaluation of the natural enemy?
7. Discuss your pest situation with several different companies to determine which seems most knowledgeable about its product and your pest problem.

Biological Control in Small Grains

Conservation of existing natural enemies is the most important approach to biological control in small grains. It is important to recognize beneficial insects and consider their impact on pest infestations when making pest control decisions. Using insecticides only when necessary based on field scouting and economic thresholds helps conserve natural enemy populations.

Exotic natural enemies of greenbugs and the Russian wheat aphid have been imported. Texas A&M University is releasing them to establish permanent populations. Parasites from the Midwest also have been released to help control Hessian fly in Texas.

There is little information on the effectiveness of augmenting natural enemies for control of insect pests in wheat. Until definitive information is available (what natural enemy is effective, release rate, timing, etc.), the Texas Agricultural Extension Service cannot provide guidelines for the use of augmentation for insect control in wheat.

Wheat Pests and Their Natural Enemies

Greenbugs

Greenbugs, like other aphids, are attacked by a variety of predators and parasites. These include the parasitic wasps, several species of lady beetles, lacewings and damsel bugs. These beneficials help keep greenbug populations from increasing to damaging levels in many years.

Parasitic wasps: *Lysiphlebus testaceipes, Diaeretiella rapae* and *Aphelinus varipes* are tiny, black wasps which parasitize greenbugs wherever this pest is found. Although the adult wasps are not commonly seen, wheat producers should be able to recognize the distinctive parasitized greenbug mummy which remains attached to the wheat leaf. Greenbug mummies parasitized by *L. testaceipes* and *D. rapae* are beige or tan and are round and swollen. Greenbug mummies killed by *A. varipes* are black and similar in size and shape to live greenbugs.

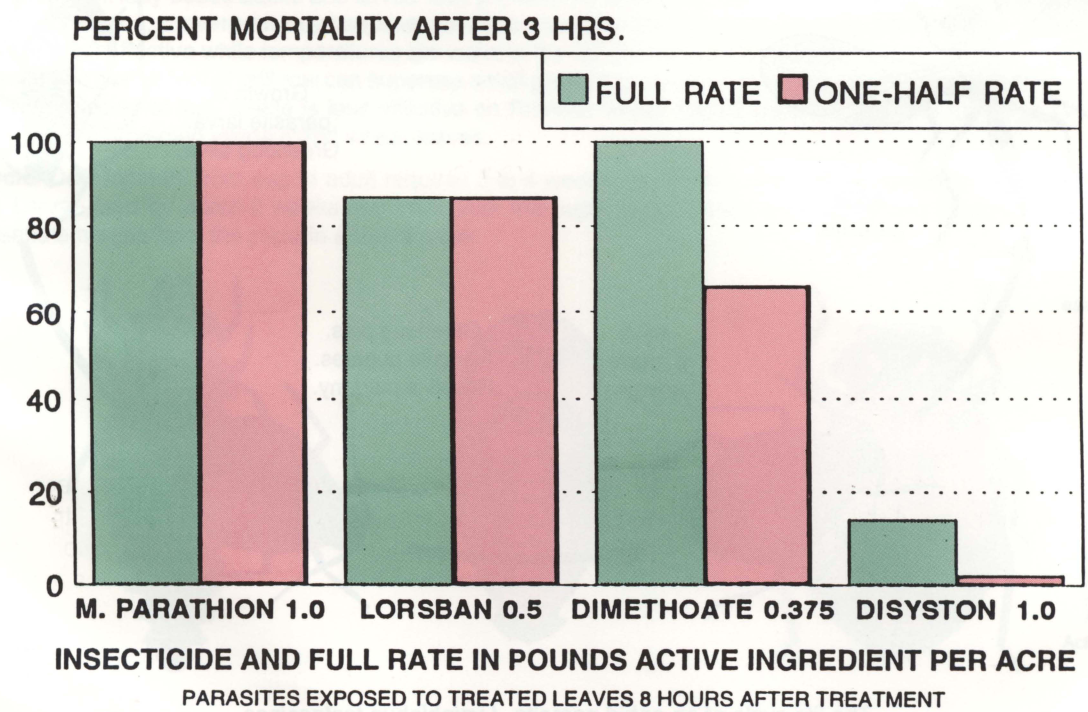
Lysiphlebus testaceipes is the most common parasite of greenbug in wheat and in some areas is the greenbug's most important natural enemy. Each female adult *Lysiphlebus* can parasitize about 100 greenbugs during her 4 to 5 days of life. More important than the death of individual greenbugs is the reduction in potential greenbug reproduction. All greenbugs are females which give live birth to three or four offspring per day. Parasitized greenbugs stop reproducing within 1 to 5 days, while unparasitized greenbugs reproduce for 25 to 30 days. As a result, parasitism can greatly reduce the rate at which greenbug infestations increase.

Temperature plays an important role in the effectiveness of parasites because parasites develop much more slowly below 65 degrees F and adults are not active below 56 degrees F. Greenbugs remain active at cool temperatures and continue to reproduce until the temperature drops to 40 degrees F. As a result, greenbug infestation can increase unchecked by parasites during cool weather.

Parasite activity in the field can be monitored by looking for greenbug mummies on wheat leaves. Weather conditions will largely determine how quickly parasites can prevent a greenbug outbreak. Remember that aphids that appear healthy may actually have parasites developing within, as the mummy stage does not develop until 8 to 10 days after parasitism. As a general rule, a greenbug infestation declines rapidly once 20 percent of the greenbugs are mummies, because at this point most of the living greenbugs are already parasitized though they have not yet entered the mummy stage.

Insecticides applied as sprays will kill adult wasps and indirectly kill immature parasites by killing their greenbug hosts. Methyl parathion and chlorpyrifos (Lorsban®) are more toxic to adult wasps and to immature parasites inside greenbugs than the systemic insecticides dimethoate and disulfoton (Di-Syston®), especially at lower rates (Figure 1).

Figure 1. Insecticide toxicity to the greenbug parasite *L. testaceipes*



Parasite Profile

Name: *Lysiphlebus testaceipes*

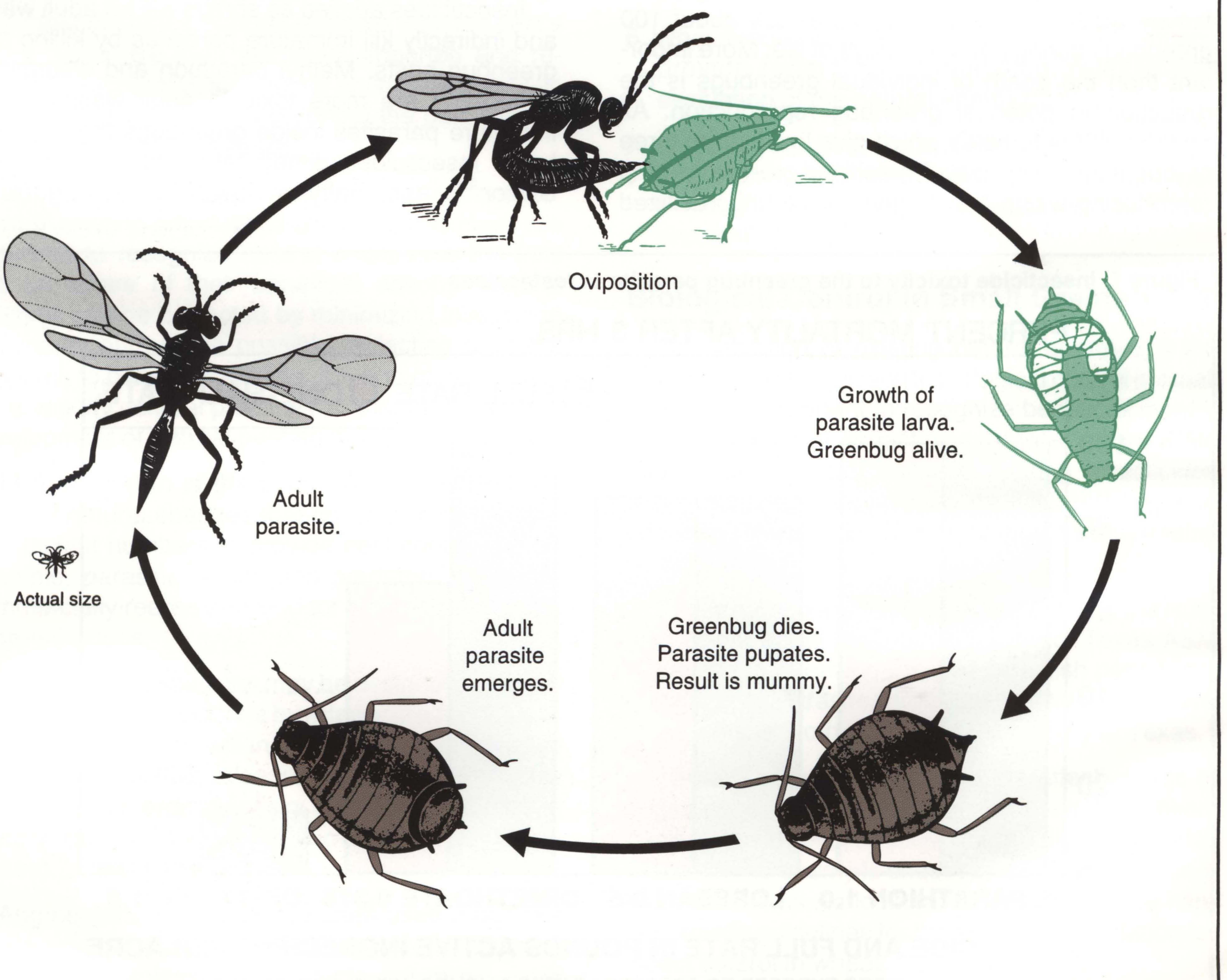
Description: A shiny black wasp slightly smaller than a mature greenbug. The wasp can be seen on warm, sunny days crawling across wheat leaves and stinging (parasitizing) greenbugs. Parasitized greenbugs are swollen and tan and are called "mummies."

Role: One of the most important natural enemies of the greenbug in wheat and sorghum. Once about 20 percent of the greenbugs are in the mummy stage, the infestation usually declines rapidly. This parasite is most effective during warm weather in the fall and early spring; adults are inactive at temperatures below 56 degrees F. The parasite also attacks the corn leaf aphid, cotton aphid and others.

Life cycle: The female pierces (stings) the greenbug and deposits an egg inside. In about 2 days the tiny egg hatches into a grub which feeds internally on the living greenbug. The parasite becomes mature in about 6 to 8 days and then begins to twist and turn inside the greenbug host. The parasitized greenbug "seizes the leaf with a rigid death-grip and the last spark of life soon fades." Movement of the parasite larva expands and molds the greenbug's body, giving it a swollen appearance. The parasite larva cuts a hole through the bottom of the greenbug's body and fastens it to the leaf surface with silk and a glue. The swollen greenbug cadaver turns a beige to tan color and is then called a "mummy."

The parasite larva then enters the pupa stage inside the mummy and the adult parasite emerges 4 to 5 days later. The adult escapes through a circular hole it cuts in the top of the mummy. The adult parasite mates and repeats the life cycle by stinging additional greenbugs. At a constant temperature of 70 degrees F, development from egg to adult requires about 14 days.

The parasite overwinters as a larva or pupa inside a parasitized greenbug. Wasps disperse by flying and by being carried as immature parasites inside winged greenbugs. Unfortunately, *Lysiphlebus* is often attacked by other species of parasitic wasps, which can limit its control of greenbug.



The life cycle of an aphid parasite. *Lysiphlebus testaceipes.*

However, the short residual toxicity of methyl parathion allows parasites to recolonize a field sooner than when insecticides with longer residual activity are used.

Immature parasites inside greenbug mummies gain some protection from insecticides. Parathion is more destructive to parasites in mummies than dimethoate or disulfoton (Di-Syston®). Chlorpyrifos (Lorsban®) is reported to be highly toxic to *Lysiphlebus* inside aphid mummies. Higher insecticide rates increase the mortality of immature *Lysiphlebus* and extend the time before adults can survive on treated foliage. The fungicide Bayleton®, used to control leaf rust on wheat, also is very toxic to adult parasites.

Lady Beetles: Several species of lady beetles can be found in Texas wheat, including the convergent lady beetle (*Hippodamia convergens*), the seven-spotted lady beetle or C-7 (*Coccinella septempunctata*) and the much smaller species *Scymnus loewii*.

As a group, lady beetles provide some control of aphids in small grains every season. But since lady beetles consume the aphids they leave no evidence of their control. Sometimes the only indication is the lack of significant aphid problems later in the year.

No one lady beetle species can completely reduce an aphid population, and research has shown that augmentation by releasing lady beetles is of little benefit. The most significant action a farmer can take to help lady beetles control aphids is conservation. Conservation primarily means avoiding broad-spectrum insecticides and using the lowest rate of insecticide that achieves adequate control of the target pest. It is also helpful to apply insecticides when the lady beetle population consists of egg or pupal stages rather than young larvae.

Convergent lady beetles alone or in combination with parasitic wasps often suppress greenbug and bird cherry-oat aphids in wheat in the Texas Rolling Plains. The number of lady beetles that develop in a field depends on environmental conditions and the size of the aphid population. Lady beetles have the greatest effect on greenbugs before temperatures become extremely cold in November and when temperatures warm up after mid-February. During extremely mild winters, lady beetles may be active in wheat fields in December or January. Small greenbug populations have been suppressed by lady beetle densities of one beetle per 10 feet of drill row.

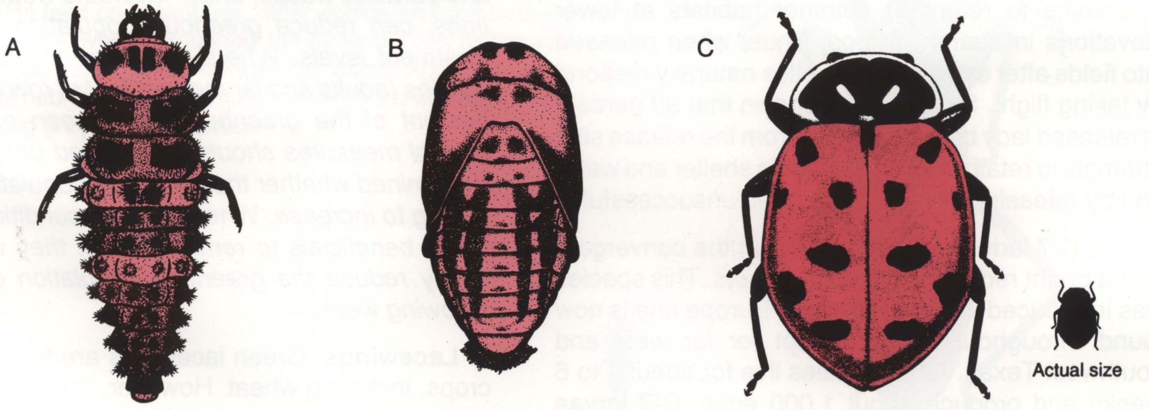
Predator Profile

Name: Convergent lady beetle, *Hippodamia convergens*

Description: This is the common orange lady beetle with six small black dots on the wing covers. The black plate (pronotum) just behind the head has two diagonal white lines which appear to converge, thus the common name convergent lady beetle. The bright yellow eggs are laid in groups on leaves. Larvae are alligator-shaped and black with rows of orange spots.

Role: Convergent lady beetle adults and larvae feed primarily on aphids but also eat other insect eggs and larvae. Under laboratory conditions, convergent lady beetle larvae consume about 20 greenbugs per day. Like the parasitic wasps, lady beetles are most effective while temperatures are warm in the fall (November) and again after mid-February. Lady beetle densities of one per 10 feet of drill row can suppress small greenbug infestations during mild weather in the Texas Rolling Plains. This species of lady beetle is less effective on Russian wheat aphids because they are too large to reach the pests, which are protected inside rolled wheat leaves.

Life cycle: Development from egg to adult requires 3 to 4 weeks, depending upon the temperature. Eggs hatch in 3 to 4 days. Larvae feed for about 2 weeks and then enter the pupal stage, which is immobile and attached to a leaf. The adult beetle emerges from the pupa in about a week.



The convergent lady beetle. *Hippodamia convergens*. A) Larva. B) Pupa. C) Adult.

Predator Profile

Name: Green lacewing fly, *Chrysoperla carnea*

Description: Adult green lacewings are delicate, slender insects 1/2 to 3/4 inch long with large wings held roof-like over their bodies. The green wings have a fine, net-like pattern of veins. Their eyes are a bright gold color.

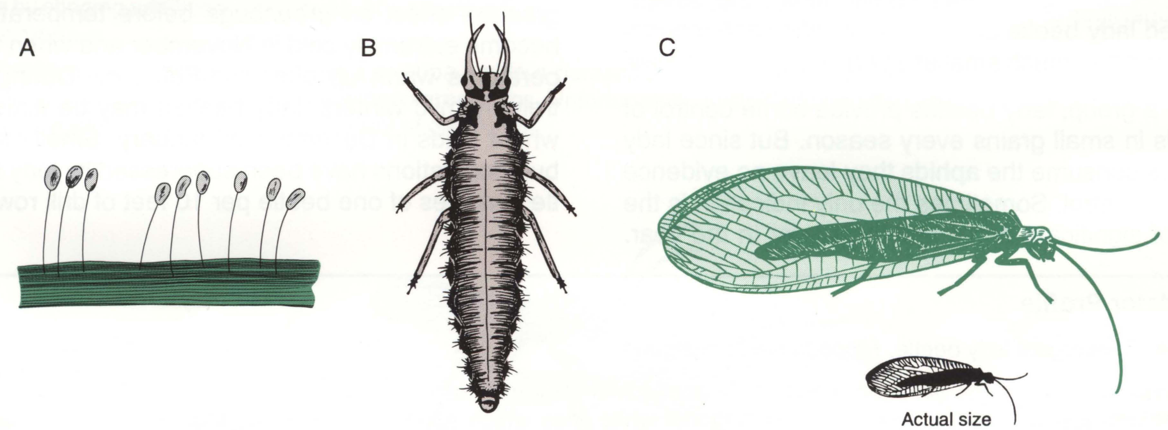
Larvae are alligator-shaped, grayish-brown and have long sickle-shaped mandibles protruding from their heads. Newly hatched larvae are very small (less than 1/8 inch long), while mature larvae are 1/4 to 3/8 inch long.

Eggs are laid singly on top of a fine thread attached to leaves or stems and are easily seen and recognized.

Role: Lacewing larvae feed primarily on aphids in wheat but also attack small caterpillars, insect eggs and mites. They are most common in wheat in the spring. Although the adults of some species are predators, adult *Chrysoperla carnea* feed only on honeydew, nectar and pollen.

Life cycle: Eggs hatch in 3 to 6 days. Larvae are voracious predators and will eat other lacewing eggs and larvae. Larvae feed for about 2 weeks and then spin spherical white cocoons of tough silk. The larva pupates inside the cocoon and the adult lacewing emerges in about 10 days.

Upon emergence, adult lacewings make long dispersal flights regardless of the presence of food. Lacewings fly at night and may travel several miles. Females must feed on nectar, pollen or aphid honeydew to produce eggs. Females lay their first eggs 4 to 6 days after emergence. Adults live several weeks, during which they lay 200 or more eggs.



The common green lacewing. *Chrysoperla carnea*. A) Eggs. B) Larva, commonly known as an "aphid lion." C) Adult.

In California, huge numbers of convergent lady beetles hibernate in masses on mountain sides and are easily collected and stored until sold in the spring. As early as 1910 farmers were purchasing lady beetles from California and releasing them in an attempt to control aphids. In their native environment, however, beetles emerging from hibernation fly from the mountains to return to summer habitats at lower elevations in search of food. Thus, when released into fields after storage, the beetles naturally respond by taking flight. Studies have shown that 99 percent of released lady beetle adults fly from the release site; attempts to retain them by providing shelter and water and by releasing at night have been unsuccessful.

The C-7 lady beetle is larger than the convergent and is bright red with seven black spots. This species was introduced into the U.S. from Europe and is now found throughout Texas except for far west and southwest Texas. Adult females live for about 4 to 6 weeks and produce about 1,000 eggs. C-7 larvae feed for about 2 weeks, consuming about 20 greenbugs per day in laboratory studies.

Scymnus is a small, dull brown beetle with a V-shaped black area down the centers of the wing covers. Larvae are covered with long, waxy filaments and feed on aphids and mites.

Heavy, rapidly increasing greenbug infestations can cause excessive damage; however, lady beetles and parasitic wasps, under favorable weather conditions, can reduce greenbug populations to below treatment levels. Where there are one to two lady beetles (adults and larvae) per foot of row or 15 to 20 percent of the greenbugs have been parasitized, control measures should be delayed until it can be determined whether the greenbug population is continuing to increase. When weather conditions permit these beneficials to remain active, they will significantly reduce the greenbug population during the following week.

Lacewings: Green lacewings are found in many crops, including wheat. However, there is little information on the importance of lacewings in the biological control of greenbugs The larval stages of all lacewings are predators which feed primarily on aphids but also on insect eggs and small caterpillars. The adults of some lacewing species, such as *Chrysoperla carnea*, feed only on honeydew or pollen. Lacewing larvae are not common in wheat but compliment other predators. The number of lacewing adults usually peaks in April and May in wheat fields. The brown lacewing also occurs in wheat.

Russian Wheat Aphid

The Russian wheat aphid is a new pest in the U.S., having been first reported in 1986 near Muleshoe, Texas. Many of the natural enemies of greenbug also attack Russian wheat aphid. However, lady beetles such as *Coccinella* and *Hippodamia* are too large to enter the rolled leaves in which Russian wheat aphids are found. There may be natural enemies in this pest's original range that could be imported for biological control. Entomologists began searching for natural enemies of Russian wheat aphid in 1988 in the Middle East and central Asia, where this pest is believed to have originated, and in Europe. Since then, several promising natural enemies have been collected, reared and released in Texas and elsewhere. A species of parasite imported from France, *Aphelinus asychis*, has been recovered near Amarillo. *A. asychis* is a very small parasite that can enter the curled leaves of wheat plants where Russian wheat aphids feed. Researchers are working to determine how well it and other released natural enemies may be controlling Russian wheat aphids.

As with greenbugs, predators and parasites often provide enough control to keep Russian wheat aphids below the economic injury level (Figure 2). Therefore, it is important to conserve natural enemies. Before an insecticide is applied, the farmer should properly assess the density of an aphid population and determine whether it is increasing or decreasing. If the aphids are increasing rapidly and few lady beetles and parasites are present, an insecticide application may be necessary.

Hessian Fly

The Hessian fly is found throughout north central and central Texas. Damaging outbreaks have occurred periodically since 1984, although recent infestations have been isolated. The decline in Hessian fly damage has been attributed to the planting of wheat varieties resistant to Hessian fly and an increase in parasitic wasps which attack this pest.

Several species of tiny wasps parasitize the Hessian fly in the spring and may kill up to 70 or 80 percent of Hessian flies at that time. *Homoporus destructor* and *Eupelmus allynii* are the most common parasites in Texas. The female parasite lays her eggs inside Hessian fly puparia (flaxseed stage) and the parasite larva feeds on the developing Hessian fly. The adult wasp emerges through a hole cut in the puparium. Puparia from which Hessian fly adults have emerged are torn and ragged at the top, while those killed by a parasitic wasp have a neat hole cut in the side.

Another wasp, *Platygaster hiemalis*, attacks the Hessian fly in the fall when the pest often is most damaging. This parasite was introduced from Indiana into Texas in 1991 but is not yet established.

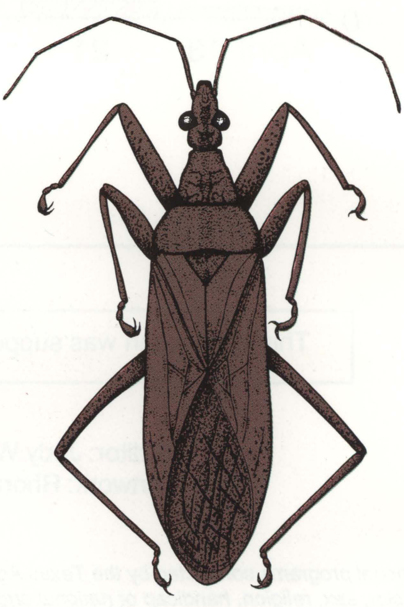
There is little information on how to conserve Hessian fly parasites. Foliar insecticides are probably detrimental to adult parasites and should be applied only if needed to control pests other than Hessian fly.

Predator Profile

Name: Nabid or Damsel Bug

Description: Nabids are slender, dull tan to grey insects about 5/16 inch long. They have long legs and antennae.

Role: Nabids feed on greenbugs, other aphids and soft bodied insects. They are found in wheat throughout the winter but only as the adult stage. Adults do not begin to reproduce until about April and, as a result, densities of nabids cannot increase earlier in the season in response to an increasing greenbug infestation.



Actual size

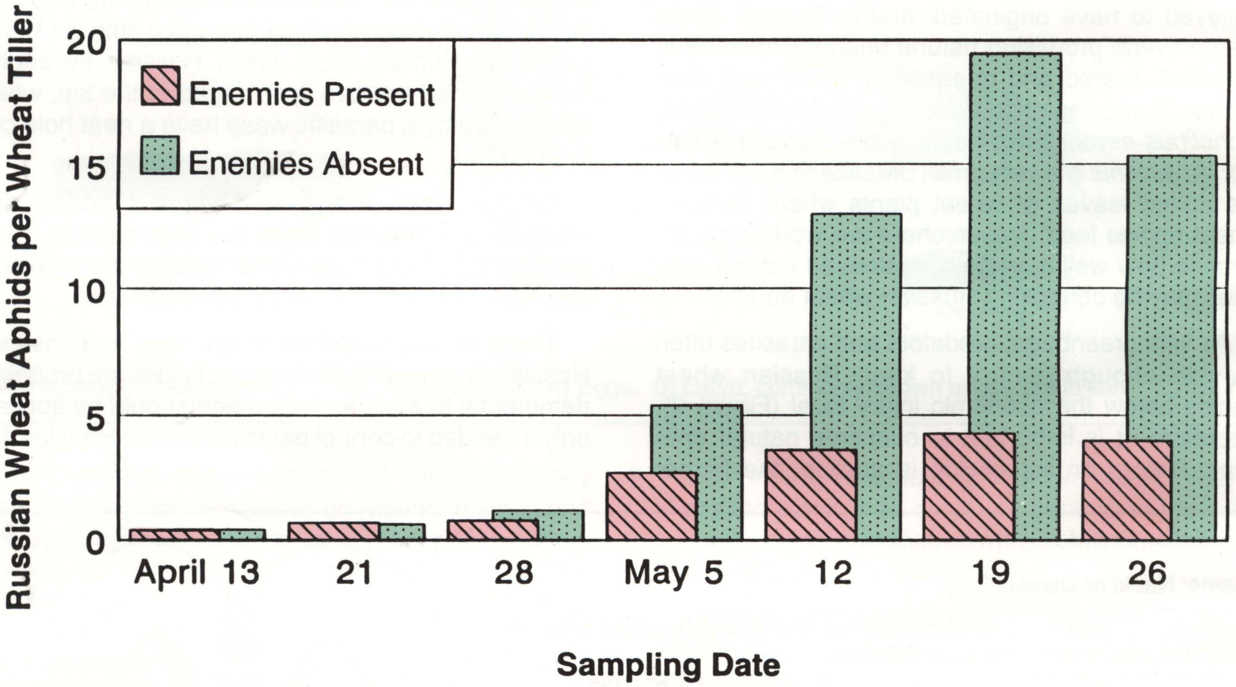
Armyworms

The true armyworm and the fall armyworm are parasitized by several species of wasps and flies. However, these natural enemies are apparently less effective during cool, rainy weather, and armyworm moths can fly long distances and escape them.

A parasitic wasp which commonly parasitizes the fall armyworm is *Chelonus*. The female deposits her eggs inside the armyworm egg. Upon hatching, the parasite larva consumes the armyworm. The parasite then spins a tough, white cocoon in which it develops to the adult stage. Groups of 10 or more of these white cocoons can be seen where an armyworm was consumed by these parasites.

Figure 2. Predators and parasites in action.

Insect predators and parasites are very small and are often effective at low numbers. When they are effective, pest numbers do not become threatening and, as a result, the benefit of these natural enemies often goes unnoticed. The importance of natural enemies can be experimentally measured by excluding them with cages. The graph below shows the number of Russian wheat aphids in wheat when natural enemies were present or absent. Parasitic wasps, lady beetles and other predators could not enter the closed cages and, as a result, the number of Russian wheat aphids rapidly increased in late May. In contrast, the open cages allowed natural enemies to enter and attack Russian wheat aphids. As a result, aphid numbers were much lower.



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